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Issued August 8, 1911.

U. S. DEPARTMENT OF AGRICULTURE,

BUREAU OF SOILS—CIRCULAR No. 37.

MILTON WHITNEY, Chief of Bureau.

SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XV.

THE CLYDE LOAM.

BY

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WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1911.

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SOILS OF THE EASTERN UNITED STATES AND THEIR USE—XV.

THE CLYDE LOAM.

GEOGRAPHICAL DISTRIBUTION.

The Clyde loam constitutes one of the most extensive soil types which has thus far been encountered within the area of the Glacial Lake and Terrace Soil Province. It has been encountered in 11 different soil survey areas located in four different States, and an aggregate area of 561,068 acres has been mapped. It occurs to a limited extent in western New York and in extensive areas in the southern peninsula of Michigan and in northern Indiana. Considerable areas have also been encountered in some portions of North Dakota. It is probable that the largest areas of the Clyde loam will be encountered in Michigan and adjoining portions of Indiana and Ohio as the soil survey work progresses in those States.

CHARACTERISTICS OF THE SOIL AND SUBSOIL.

The surface soil of the Clyde loam, to a depth in excess of 8 inches, is a moderately friable to rather heavy and compact loam, usually dark gray, brown, or black in color. Near the margins of the smaller areas of this type there is not infrequently a considerable mixture of sandy material, and in such instances the surface soil is more friable and of a lighter gray color. In all of the larger areas where it is developed and in the central portion of even the smaller areas it is almost jet black and contains such large amounts of organic matter as to be almost muck. The depth of the surface soil varies to a considerable degree, ranging from 8 or 10 inches near the margin of the type to a depth of 18 or even 24 inches in the central portions of large areas or in depressed locations occurring in any portion of the type. The subsoil of the Clyde loam is a gray, drab, or blue clay, sometimes mottled with yellow or brown iron stains. In almost all instances this subsoil is stiff, plastic, and impervious, but in certain instances where it is underlain at no great depth either by layers of peat or of marl the subsoil material may be somewhat jointed and less impervious than the average of the type. The Clyde

loam in the majority of the areas where it has been encountered is stone free and even gravel is lacking. It is only in marginal areas or in locations where the surface covering of typical Clyde loam is somewhat thin that the stone or gravel of underlying glacial formations becomes evident. In Niagara County, N. Y., a phase of the type, which constitutes only a thin covering over underlying glacial material, is marked by stone and bowlders over its surface. This, however, is unusual.

The Clyde loam is separable from the other members of the Clyde series because of its different texture, being considerably more stiff and plastic than the sandy loam and possessing a loamy covering over the stiff clay which characterizes the Clyde clay loam or clay.

The Clyde loam differs from the members of the Fargo series, also of glacial-lake origin, in that the latter are decidedly and distinctly calcareous in the subsoil in all areas where they have been encountered, while the Clyde loam is not so characterized. It differs from the soils of the Carrington series, in that the latter possess the bowlder clay or till subsoil characteristic of that series.

Thus the Clyde loam and its associated soils of the series may be readily distinguished from other dark-colored or black soils of the general region.

SURFACE FEATURES AND DRAINAGE.

The Clyde loam invariably occupies level or depressed areas which at some previous time have constituted the beds of glacial lakes or of large swamps. Such areas occur not only within the regions formerly occupied by extensions of Lakes Erie and Huron, but also in the beds of many smaller extinct glacial lakes which were ponded between the inequalities of the rolling to ridged glacial drift. In all instances the mineral matter from adjoining uplands was washed down and deposited in the form of fine or coarse sediments within these small or large lake beds, and as the water became shallower, vegetation gained a foothold, giving rise to the incorporation of large amounts of mucky or peaty organic remains within the zone which now constitutes the surface soil.

The surface of the Clyde loam is almost invariably level, although in some areas low, rounded knolls and gentle swells within the general area of the ancient lake beds may also be covered by the same characteristic mucky, swamp deposits. In all cases the area of the Clyde loam is distinctly depressed below the level of adjoining glaciated uplands and glacial moraines or below the level of the marginal glacial-lake deposits.

The altitude of the surface of the Clyde loam varies considerably in the different areas where it has been encountered. Thus in western New York, in Niagara County, the surface of the type ranges

from 300 to 600 feet above sea level, while in the vicinity of Saginaw Bay, in the southern peninsula of Michigan, the altitude of the type ranges from approximately 600 feet to about 750 feet above tide. Other separate areas in southern Michigan and northern Indiana have about the same altitude, while the areas in North Dakota are located at altitudes of approximately 1,500 feet above sea level.

In all cases the Clyde loam is either poorly drained at the present time or was poorly drained prior to its occupation for agricultural purposes. In practically all areas where it occurs the Clyde loam constituted wooded swamps or grass-grown marshes in the days of pioneer occupation, and in the majority of instances other, upland, soils were first cleared and occupied. Later the obstructed natural drainage was improved by the straightening of streams and the opening of drainage ditches, and gradually increasing areas of this black mucky soil have been brought under cultivation. The Clyde loam in its undrained condition, wherever it is encountered, either constitutes swamp not occupied for any agricultural purpose or else forms pasture lands upon which cattle are grazed during the later months of the summer, or where, in the treeless areas, swamp grass is cut for hay. It has only been through the establishment of artificial drainage that this soil has been made available for agricultural use.

LIMITATIONS IN USE.

Owing to the swampy or semiswampy condition of the Clyde loam prior to drainage, the surface soil is frequently found to be in a puddled, compact state, sticky and impervious when wet and drying out to a clodded or cementlike surface when dry. These effects of poor drainage are emphasized where the finer-grained material is found in lower lying areas that have been under cultivation for only a short time. In such cases the soil proper is frequently stiff and sticky and clods badly when plowed. The continued cultivation of the type, however, and the long-continued operation of frost upon well-drained areas tends to correct this condition and to make the Clyde loam an extremely valuable soil for the production of the majority of the general farm crops suited to the temperate climate within which the type is most extensively developed. Because of the characteristics of texture, structure, and drainage already described, the Clyde loam is better suited to the production of the small grains and of grass than to the growing of corn or potatoes. These same characteristics of the soil, together with its high moisture-holding capacity, constitute it one of the best sugar-beet soils found within the eastern, humid States. The appreciation of this crop adaptation of the Clyde loam has led to its extensive utilization for sugar-beet growing in the southern peninsula of Michigan, and many thousands of acres of sugar beets are annually planted upon the type.

The same high organic matter content, fine texture, and high water-holding capacity constitute the Clyde loam a type of soil well suited to the production of cabbages, onions, and celery among the later market-garden crops, and of late strawberries among the small fruits. In former years peppermint was also grown to some extent upon areas of the Clyde loam not fully drained. More recently market conditions have decreased the acreage of this crop grown in the United States, and it is practically not grown upon the Clyde loam at any point at the present time.

The somewhat imperfect drainage of the type has limited the acreage devoted to corn or potatoes, and has also prevented the extensive production of winter grain crops except upon areas which have been completely drained through the installation of open ditches supplemented with tile-drainage systems. On the other hand the spring grain crops, particularly oats, produce excellent yields upon the Clyde loam. The only difficulty experienced in the production of oats is the tendency toward an excessive growth of straw, which results not infrequently in the lodging of the crop before it is ready for harvest. Similarly timothy and other tame grasses grow luxuriantly upon the Clyde loam, while upon all of the better drained areas clover is also a very successful crop. It may be said in general that not only the acreage which may be devoted to the production of tilled crops, of grains, and of grass is limited by drainage, but also that the crop yields obtained are largely limited by the same factor.

Geographically the Clyde loam is located throughout the greater part of its extent within a region which possesses a growing season sufficiently long for the production of all of the general farm crops and sufficiently humid to supply an abundant amount of moisture for crop use, particularly under the topographic and drainage conditions existing on the type. In the northwestern areas where it occurs, the growing season is somewhat shorter and corn is practically eliminated as a profitable crop. In North Dakota artificial drainage has not been installed to any extent upon the type, and the crop yields of the grains and of grass vary decidedly with the attendant circumstances of precipitation during any given year. In years of abundant rainfall yields are liable to be low, but in the drier years the Clyde loam produces the maximum yield obtained from any soil type in this drier portion of the country.

IMPROVEMENT IN SOIL EFFICIENCY.

The primary requirement of the Clyde loam is, in all cases, the improvement of its drainage conditions. In the more eastern areas where it occurs, a large percentage of the type is now under cultivation, but a great deal of artificial drainage was necessary before

any extensive use of land of this character was possible. Practically all of the smaller streams flowing through the type have been straightened and enlarged or else they have been supplemented by the construction of large open ditches and canals, frequently many miles in length. In certain areas where the Clyde loam has been extensively mapped, ditches of various sizes are found along practically every section line, thus existing at intervals of a mile, and not infrequently main drainage lines are also dug along the quarter sections. Some of these drains are only sufficiently large to remove the surface waters in seasons of excessive rainfall, while others provide for both surface and subsoil drainage. In the latter instances tile-drainage systems, constructed to relieve the marshy conditions of adjoining farms, have their outlet into these open ditches at varying depths below the surface.

The construction of these extensive drainage systems has rendered possible the agricultural occupation of the type, but even with the installation of these improvements, some of the most important crops are seriously injured during seasons of excessive rainfall, while the surface soil is not infrequently baked and clodded through rapid surface evaporation during periods of drought.

Complete drainage involves a considerable expenditure of money for the construction of open ditches and for the laying of tile. In the large areas of the Clyde loam, which are frequently encountered, such improvements will be practically impossible if undertaken by the individual farmer. As a consequence, State laws have been enacted in many States where the type is developed which make drainage a public work, under the direct charge and supervision of county drainage commissioners, appointed by the local county officers. Under these laws the formation of drainage districts, to include considerable areas of land, is made possible and the cost of the installation of this improvement is equably assessed against the land improved in due proportion to the benefits derived. Through the formation of such districts much larger areas may be drained than would otherwise be possible, and the assessment cost against large areas almost invariably results in a decided reduction in the cost to the individual farmer.

Of course, the cost of the installation of any particular drainage system varies decidedly in the different districts which have been organized. The length and size of the required outlets will vary. The frequency with which these outlets must be constructed and the size and frequency of the tile lines all vary, even within the same drainage district, giving rise to decided differences in cost for the individual farm or land owner. In general, it may be said, however, that land of this character may be drained at a cost ranging from $12 to $25 an acre. Frequently the land itself before drainage had a valuation of

not more than $5 or $10 an acre for pasturage purposes and for the small amount of firewood or timber which might be furnished from the swamp forests. When thoroughly drained and brought under cultivation, even with the general farm crops, the Clyde loam is valued at prices ranging from $35 to $100 an acre or even more. These prices are easily exceeded by such areas of the type as are available for the production of the more intensively tilled farm crops, like sugar beets, cabbages, onions, celery, or strawberries. Thus a considerable expenditure for the perfection of drainage systems is justified over the greater proportion of the territory occupied by the Clyde loam.

In the majority of the areas where the Clyde loam is found, rational crop-rotation systems have already been adopted, and in all of the more eastern areas considerable attention is paid to the manuring and fertilizing of the general and special crops produced upon the type. In the North Dakota areas, however, grain growing predominates, and the short growing season in that locality renders the introduction of a hoed crop into the rotation decidedly difficult. It would seem desirable to produce the more hardy varieties of corn in alternation with the grain crops and to seed the land down to timothy and alsike clover, even in the region where the Clyde loam is chiefly valued as a spring-wheat soil.

The surface soil of the Clyde loam is usually abundantly supplied with organic matter through the processes of its original formation. In the stiffer and more clayey areas, however, it is frequently desirable to apply the coarser and more strawy portions of the stable manure produced upon the farm to the Clyde loam, largely for the purpose of loosening the heavy loam surface soil and promoting internal drainage and aeration. At the same time the physical structure of the soil is decidedly improved and its maintenance in good tilth is made easier.

LIMITATIONS UPON SPECIAL CROPS.

Because of its rather fine texture and of its great moisture-holding capacity, due to texture and high organic-matter content, the Clyde loam is not suited to the production of any early truck crops in any of the localities where it occurs. The same characteristics, however, render the soil particularly favorable to the production of sugar beets and later market garden and truck crops, such as cabbages, onions, celery, and late strawberries. With the exception of sugar beets the crops enumerated are grown only to a limited extent, but wherever transportation facilities and markets are available each one of these crops might well be extended in acreage. Cabbages in particular are well suited to a soil of this class, producing large yields with solid heads, as well suited to storage as

to immediate marketing. The culture of the crop is little more difficult than that needed in the production of corn and the labor not as exacting as that required in the production of sugar beets. It is not probable that any large area of onions or of celery would be advisable upon the individual farm where the Clyde loam is developed, since muck and peat soils are also found extensively in the same general regions, and the muck soils in particular are somewhat better adapted to the production of these crops. Both onions and celery, however, may be produced with considerable profit upon the Clyde loam. The production of late strawberries suited to the market demands, after the southern market berries have been exhausted and even after the local berries from better drained upland soils have passed out of the market, might well be developed upon those areas of the Clyde loam accessible to transportation facilities to the larger northern cities. A considerable demand for these late berries exists and the prices paid are only less than those paid for the extra early berries of the first part of the season.

Wherever any of these special crops are to be produced upon the Clyde loam the greatest care should be taken in the thorough drainage of the fields. Such extra care is justified by the high acreage value of the crops to be grown. Similarly, the careful preparation of the land, including the thorough fining of the surface soil and the incorporation of stable manures, will be thoroughly justified and recompensed.

EXTENT OF OCCUPATION.

The extent of occupation of the Clyde loam varies considerably in the different localities where it occurs. In the more eastern districts from 50 to 80 per cent of the type has been cleared, drained, and brought under cultivation. In the more western regions a considerable proportion of the type is occupied for grain production during the years of moderate or deficient rainfall, while in years of excessive precipitation only a small proportion of the type is utilized for the growing of any crop. The establishment of drainage in such areas would render possible the occupation of all of the areas of the Clyde loam during all seasons, a condition which is impossible until the poor natural drainage has been supplemented by open ditches, and, in some cases, by the installation of tile. In all areas where it occurs, the occupation of the remainder of the type can be made possible only by careful attention to thorough drainage. In the more eastern areas even those portions of the type not used for grain, grass, or tilled-crop production are frequently utilized for pasturage or the cutting of wild hay. Small areas still remain forested or in a swampy condition.

There is an excellent opportunity for the more intensive occupation of the Clyde loam over a considerable proportion of its area. It is so well suited to the production of quite a number of special crops that increasing demand for these crops will naturally result in their increased production to the exclusion of the spring grains and grass now extensively grown upon the type. It is probable that increased occupation of the Clyde loam will take this direction of more intensive cultivation.

CROP ADAPTATIONS.

General crops.—In the case of the Clyde loam, a larger acreage of the type is devoted to the production of grass for the cutting of hay than to any other crop. The type is not only well suited to produce large yields, but the management of the soil and of the general farming system in the areas where it occurs has brought about a crop rotation usually consisting of one year devoted to the production of a hoed crop, one or two years devoted to small grain growing, to be succeeded by two, three, or even five years of grass production in the course of the rotation. Because of the adoption of such long-term rotations, in which the land is frequently occupied during half of the entire period by the stand of grass, the acreage of this crop far exceeds that devoted either to the small grains or to the hoed crops. The yields of hay vary considerably in the different areas where the Clyde loam has been encountered. In general, in southern Michigan, northern Indiana, and western New York the yields of hay range from 1¼ to 2 or even 2½ tons per acre. The average yields for the Clyde loam in these locations may be confidently stated at 1½ tons per acre or greater, dependent somewhat upon seasonal variations in the rainfall. Mixed timothy and clover constitute the principal acreage, although upon the better drained areas clover, seeded alone, constitutes an important crop, both for the production of hay and, in central Michigan, for the production of clover seed. In North Dakota the area devoted to the production of the tame grasses is so limited as to be almost negligible. However, considerable areas of wild grasses are cut, giving the high average yield of 1½ to 1¾ tons per acre. Thus, the Clyde loam is an admirable soil for the production of the grasses. The alsike clover and the medium red clover are used to a considerable extent both in mixed and pure seeding. It has been found that the alsike clover will make an excellent growth even where drainage has not been thoroughly established, while the medium red clover is somewhat more critical and requires good to perfect drainage to produce its maximum yields.

Among the small grains, spring wheat is the most important, although in some areas winter wheat is also grown. The acreage devoted to this crop in the more eastern States is diminishing and the

yields are not particularly high. Upon the Clyde loam they range from 10 or 12 bushels per acre to 20 bushels or more. The average, however, is not much above 15 bushels per acre for this type. This is, nowever, in excess of the yields secured upon many of the upland soils in the same general region. In the more western areas, where spring wheat is exclusively grown, large acreages are seeded upon the type whenever the moisture conditions are such that it can be prepared and seeded. In seasons of normal or somewhat deficient rainfall the yields of spring wheat in North Dakota upon the Clyde loam range from 12 to 18 bushels per acre, with a general average in the vicinity of 13 bushels. In wet years the type is either not seeded to wheat or the crop is liable to be a partial or complete failure owing to the lack of drainage.

Next to wheat, oats constitute the most important grain crop, considerably exceeding the acreage planted to corn on the Clyde loam. Oats are even better suited to this type than either winter or spring wheat, and the yields are high in the different areas where the crop is grown. In Michigan the yields range from 35 to 60 bushels per acre, while the general average through a long period of time may be stated at 40 bushels per acre, or somewhat greater. Consequently the oat crop is, to a considerable degree, displacing wheat as the small grain for the Clyde loam. Aside from a tendency toward excessive growth of straw, already noted, the Clyde loam constitutes an almost ideal soil for oat production.

In all of the more eastern areas where the Clyde loam is developed corn constitutes the most extensive intertilled crop produced upon it. The yields are fair to good, ranging from 25 to 45 bushels per acre, with a general average in the vicinity of 35 bushels. The acreage planted to corn upon the Clyde loam in North Dakota is insignificant, although the yields are fair, considering the climatic disadvantages, the rather intractable nature of the surface soil, and its almost total lack of drainage. The yields reported upon the small acreage planted are in the vicinity of 25 bushels to the acre.

Sugar beets.—The Clyde loam is the most important sugar-beet soil in the eastern areas where the crop is produced. The importance of the production of sugar beets in the various portions of the United States where climatic conditions are favorable to the growing of this crop caused a somewhat extensive investigation of the different soils suitable for sugar-beet production, particularly in the Eastern States. This study was undertaken by the Bureau of Soils principally during the summer of 1904, and soil surveys were made in the southern peninsula of Michigan, which included the areas where the development of the crop had attained its greatest extent. Sugar beets are grown upon quite a wide variety of soils, all of them somewhat similar in their principal characteristics. From the observations made of

field conditions in the districts where sugar beets were thus extensively grown, it became evident that the physical condition of the soils to be devoted to the crop must be such as to maintain a considerable supply of moisture throughout the growing season, while at the same time the soil should be sufficiently loose and porous to allow easy penetration of the roots and the development of a smooth even beet of uniform size. Variations in the character of the soil also produced a considerable effect upon the percentage of sugar in the beets and upon the index of purity. The qualifications of a good sugar-beet soil are best met by the Clyde loam among all the soils of any large extent which are found in the Eastern States, although more limited areas of other related soil types are also capable of profitable development for sugar-beet growing. In addition to the Clyde loam, the Clyde fine sandy loam and the Clyde clay, which are associated with it in all of the eastern areas, are fairly well suited to sugar-beet production, though the yields upon the former are not so heavy as upon the loam, and the stiff nature of the surface soil of the Clyde clay does not favor the intensive tillage required for the production of the crop nor the easy development of large-sized and smooth beets.

Sugar beets are almost invariably planted upon land which was in sod the previous year. They thus take about the same place in the crop rotation as that occupied in other areas by corn, and not infrequently displace a part of the corn acreage where sugar beets are grown. The land is prepared in about the same manner as for the corn crop, and no special preparation or fertilization is ordinarily employed. The beets are seeded upon ridges through the use of a special drill, and after the young beets have made a growth of several inches in height it is necessary to go through the crop with a hoe, trimming out the beets to a stand, and at the same time carefully removing grass and weeds from the row. Throughout the season the beets require constant and careful tillage, a considerable part of which must be performed by hand labor, although the ordinary cultivator used for tilling the corn crop is used for the inter-row tillage. A considerable amount of hand labor is also required at harvest time, thus giving rise to a relatively high labor charge per acre in the production of the crop. In fact, sugar beets would be more extensively grown in the majority of the eastern communities where market is available, except for the large amount of labor required and the high cost of their production.

The yields secured are extremely variable, dependent somewhat upon the season, somewhat upon the proper drainage of the soil, and to a considerable degree upon the care which is taken of the crop during the growing period. The yields upon the Clyde loam range from 5 to 15 or 18 tons per acre, being considerably higher than upon the majority of other soils in the same general region,

with the possible exception of the Clyde fine sandy loam and the Clyde clay. In general the average yield per acre on the Clyde loam through a period of years may be stated at 7 to 10 tons an acre. There is little variation in the percentage of sugar, or in the index of purity between the beets grown upon the different members of the Clyde series. In general it may be stated that the larger and heavier the beet the smaller the percentage of sugar content, while the production of beets upon extremely mucky soils also tends to decrease the purity of the juice.

Many thousands of acres of sugar beets are annually grown upon the Clyde loam in the southern peninsula of Michigan, and there is a strong tendency to increase this acreage in all localities where an adequate supply of labor for the care of the crop can be obtained.

Special crops.—Beans are grown to some extent as an intertilled crop, preceding either wheat or oats, in both Michigan and Indiana. The yields are good, ranging from 18 to 25 bushels per acre, with an average yield of 20 bushels. Rye, barley, and buckwheat are also produced to a limited extent, giving fair yields.

In some localities there are also small acreages planted to cabbage or celery, the former crop yielding from 8 to 15 tons per acre, with an average of about 12 tons. The quality of the cabbage produced upon the Clyde loam is reported to be excellent. Only a small area of either onions, peppermint, or strawberries is now produced upon the type, although it is well suited to the growing of each of these crops when economic conditions and transportation are favorable.

FARM EQUIPMENT.

The farm equipment upon the Clyde loam does not differ materially from the equipment upon other soils in the same general regions. It may be said that larger teams and heavier tools are required for the perfect tillage of this soil than upon any others of similar or lighter textures. The somewhat plastic and dense character of both the surface soil and the subsoil requires deep plowing and thorough subsequent tillage in order to maintain the surface soil in mellow, friable condition. Since the Clyde loam is practically stone free in the majority of areas where it occurs the use of disk plows and disk harrows is easily possible. The employment of such machinery would obviate the tendency toward the forming of a plow sole or "hardpan" at the normal depth of plowing, a difficulty sometimes encountered in the use of the ordinary turning plow.

The dominance of grass, oats, and corn, as the principal crops upon the Clyde loam led to the introduction of dairying as an important adjunct to crop production in the early days of the occupation of this type. In all of the more eastern areas the excellent pasturage afforded, the heavy cutting of hay, the large yield of oats, and the

satisfactory yield of corn, all led the pioneer farmers, who were usually predisposed to dairying from their experiences in their former locations, to adopt this form of crop disposal. The dairy farms upon the Clyde loam, particularly in Michigan and Indiana, are apparently among the most profitable and best maintained farms in the region. Upon these dairy farms a considerable amount of stable manure is annually returned to the fields and crop yields are maintained at or above the average for the general locality. The production of wheat has largely been superseded by the production of corn and oats upon the majority of dairy farms. The building equipment is somewhat more elaborate because of the necessity for housing the stock and the roughage for feeding purposes upon dairy farms than upon the general crop farms found upon the Clyde loam.

SUMMARY.

The Clyde loam is an extensive and important general-purpose and special-crop soil of the Glacial Lake and Terrace Province.

It is most widely developed in the southern peninsula of Michigan and in northern Indiana, though important areas are found in western New York and in North Dakota.

The Clyde loam has been formed through the redeposition of fine-grained glacial materials in the beds of extinct glacial lakes and particularly in depressed areas where natural drainage conditions were very poor and where partially decomposed vegetable matter accumulated abundantly.

The surface soil of the Clyde loam is a dark-gray, brown, or black, somewhat mucky loam for a depth ranging from 8 to 24 inches and averaging about 12 inches over the entire extent of the type. The subsoil is a gray, drab, or blue clay loam, or clay, stiff and impervious.

In its natural condition the Clyde loam occupied extensive swampy and marshy areas found in low-lying and depressed localities. A part of the type was timbered and a part covered by swamp grasses and other low-growing vegetation.

The occupation of the Clyde loam for agricultural purposes has only been made possible through the installation of artificial drainage systems over practically all of the type which is now under cultivation. Streams have been straightened, large main and lateral canals have been dug, and a large amount of tile underdrainage has been installed for the improvement of the drainage of the type and its reclamation for agricultural purposes.

In its natural swampy condition, the Clyde loam was held at a value of $5 to $10 an acre. The cost of drainage has ranged from $12 to $25 an acre, and the valuation of the drained land ranges from $35 to $100 an acre for the production of general farm crops and even higher for the production of special crops. The drainage of the type has thus been fully justified by its increase in value.

Grass occupies the most extensive acreage of any crop grown upon the Clyde loam. The yields are high.

Both winter and spring wheat are commonly grown, with medium to low yields per acre. In all of the eastern areas the area devoted to wheat is decreasing.

Oats constitute an important small-grain crop upon the Clyde loam, giving an average yield in excess of 40 bushels per acre.

Corn is extensively produced in the lower latitudes, giving average yields of about 35 bushels per acre, with many instances of higher yield.

Sugar beets constitute the principal special crop grown on the Clyde loam, and this type is probably the best suited to the production of sugar beets of any soil to be found in the eastern States, within the climatic zone suited to beet production. The yields per acre are good and the percentage of sugar content and of purity high.

Beans, rye, and buckwheat constitute minor crops of local importance only.

The Clyde loam is also suited to the production of cabbages, onions, celery, and late strawberries, of which the first crop is the most important. Peppermint was formerly grown to some extent upon the type in Michigan.

The Clyde loam has been reclaimed and occupied for agricultural purposes to the extent of probably 80 per cent of its total area in all of the eastern localities where it is found, and the remainder of the type is also used for pasturage, the cutting of wild hay, and, to a very minor extent, for the firewood and timber growing within the swamps.

In North Dakota little effort has been made to perfect the drainage of the type, and the amount of the Clyde loam devoted to crop production varies decidedly with seasonal variations in rainfall; in seasons of scant precipitation practically all of its area is devoted to the production of spring wheat, with an average yield of about 13 bushels per acre, while in a season of excessive precipitation little of the type is sowed to wheat or else the crop yields are decidedly low.

For its proper tillage the Clyde loam requires heavy teams and improved machinery.

Owing to the special adaptation of the type to the production of grass, oats, and corn, a considerable proportion of it is occupied by a very successful dairy industry.

Approved.

JAMES WILSON,
Secretary of Agriculture.

WASHINGTON, D. C., *June 17, 1911.*

APPENDIX.

The following table shows the extent of the Clyde loam in the areas surveyed to this time.

In the first column is stated the particular survey in which the soil was encountered; in the second column, its extent of development in acres; and in the third column the volume of the Field Operations of the Bureau of Soils in which the report upon the area may be found. Those desiring a detailed description of the soil and of the general conditions which surround it in any particular area may consult these volumes in almost any public library.

Areas of the Clyde loam encountered in the soil survey.

Survey.	Area of soil.	Year of publication, Field Operations.
Indiana:	*Acres.*	
Allen County	12,800	1908
Newton County	960	1905
Michigan:		
Allegan County [1]	12,460	1901
Alma area	59,776	1904
Owosso area	71,744	1904
Saginaw area	242,496	1904
New York:		
Livingston County	7,488	1908
Montgomery County	3,200	1908
Niagara County	55,360	1906
North Dakota:		
Cando area	70,016	1904
Carrington area	24,768	1905

[1] Mapped as Allegan black clay.

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